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date

TRACK MANAGEMENT SYSTEM ON

ENTERPRISE JAVA BEANS

Field of the Invention

5 This invention relates to command and control systems, and more particularly to track management portions of command and control systems.

Background of the Invention

10 Command and control systems are widely used in military applications. In general, a command and control system integrates a plurality of sensors, devices, weapons, and communications with trained people, to accomplish specified functions, both
15 defensive and offensive. The track management system is an important part of a command and control system, in that the data upon which decisions are made by other portions of the command and control system must be correct.

20 In the past, command and control systems were integrated using various standards, such as LINK 11 and LINK 4A in the case of Navy systems. Such systems can be

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quite effective. It has been found, however,
that such systems are quite expensive to design
and manufacture, and are also expensive to
maintain and especially to upgrade. The
5 upgrading problem is exacerbated by the fact
that the original designers may no longer be
available at the time that the upgrade is to be
designed. The designers of the upgrade must
initially familiarize themselves with the
10 original system before the design of the
upgrade can commence, and this time translates
into money and delay. In addition, there is a
problem of interoperability among the various
portions of the redesigned system, in that
15 there must be a consensus among the designers
of the various portions of the command and
control system as to the data exchange
signaling protocols of the redesigned system.
This consensus necessarily takes time and
20 additional money.

Summary of the Invention

A method according to an aspect of
the invention is for operating a command and
control system which includes a track
25 management system. The method includes the
step of providing a COTS application server
arrangement capable of receiving data in a Java
Two Enterprise Edition (J2EE) compliant
protocol. Target data is generated and
30 communicated to the COTS application server
arrangement in the form of a Java Two

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Enterprise Edition (J2EE) compliant protocol. .
A plurality of computer processing arrangements
are provided, each of which is capable of
processing J2EE compliant software components.

5 In other words, the computer processing
arrangements are responsive to a COTS
application server arrangement. Each computer
processing arrangement may be a single CPU
(with its ancillary equipment), or a group or
10 cluster of computer processors. Each COTS
application server arrangement may be a single
application server (with its ancillary
software), or a group or cluster of application
servers. According to the invention, the
15 method includes, in the application server
arrangement, processing the J2EE compliant data
with a plurality of Enterprise Java Beans
software components. In effect, these are
components which are capable of being
20 dynamically controlled. The application server
arrangement also establishes those of the
computer processing arrangements in which the
data is processed. When the computer
processing arrangements which are to process
25 the various portions of the data have been
established or determined, the J2EE compliant
data is provided to the selected ones of the
computer processing arrangements, for thereby
generating processed data. Finally, the
30 processed data is provided to a user. Most
often, the user is another system or subsystem

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of the command and control system.

A method according to another mode of the invention is for operating a track management system according to another aspect
5 of the invention includes the step of providing a COTS application server arrangement capable of receiving data which is pursuant to a Java Two Enterprise Edition (J2EE) compliant protocol. Data is generated which represents
10 target information, and the data is communicated to the COTS application server in the form of a Java Two Enterprise Edition (J2EE) compliant protocol. A computer processing arrangement is provided. The
15 computer processing arrangement is capable of processing J2EE compliant software components.

In the application server arrangement, the J2EE compliant data is processed with one of
(a) an Enterprise Java Bean software component
20 arrangement and (b) a Corba software component arrangement, to establish or determine those of the computer processing arrangements in which the data is processed. The J2EE compliant data is provided to the selected ones of the
25 computer processing arrangements, for thereby generating processed data. Finally, the processed data is provided to a user.

Brief Description of the Drawing

30 FIGURE 1 is a simplified block diagram of a command and control system,

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including a track management system according to an aspect of the invention;

FIGURE 2 is a simplified notional or illustrative block diagram of software components of the track management system of
5 FIGURE 1;

FIGURE 3a represents a simplified block diagram of the allocation of one application server or an application server arrangement to a single computer processing arrangement including a single central processing unit (CPU), FIGURE 3b represents a
10 simplified block diagram of the allocation of one application server or application server arrangement to a computer processing arrangement including a plurality of CPUs, FIGURE 3c represents a simplified block diagram of the allocation of a plurality of application servers or application server arrangements to a computer processing arrangement including a
15 single CPU, and FIGURE 3d represents a simplified block diagram of the allocation of an application server arrangement including a plurality of application servers to a computer processing arrangement including plural CPUs;
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FIGURE 4a represents a simplified block diagram of the allocation of one Enterprise Java Bean (EJB) software component arrangement including a single EJB software
25 component to an application server arrangement including a single application server, FIGURE
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4b represents a simplified block diagram of the allocation of one Enterprise Java Bean (EJB) software component arrangement including a single EJB software component to an application server arrangement including a plurality of application servers, FIGURE 4c represents a simplified block diagram of the allocation of an EJB software component arrangement including a plurality of EJB software components to an application server arrangement including a single application server, and FIGURE 4d represents a simplified block diagram of the allocation of an EJB software component arrangement including a plurality of Enterprise Java Bean software components to an application server arrangement including a plurality of application servers; and

FIGURE 5a is a simplified block diagram of a computer processing arrangement capable of processing Java; FIGURE 5b is a simplified block diagram of a computer processing arrangement capable of processing Java through a Java virtual machine, FIGURE 5c is a simplified block diagram of a computer processing arrangement capable of processing an EJB software component through use of an application server and a Java virtual machine, FIGURE 5d is a simplified block diagram of a computer processing arrangement capable of processing an EJB software component through use of an application server, and FIGURE 5d is

a simplified block diagram of a computer processing arrangement capable of processing a Corba software component by the use of an application server.

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Description of the Invention

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FIGURE 1 is a simplified block diagram of a command and control system 10 according to an aspect of the invention. In FIGURE 1, a track data source represented as a block 12 generates signals. The source of data 12 may be a sensor or another system or subsystem, which generates signals which may be representative of a the existence of a target or track, and possibly its location, dimensions, and velocity. Source 12 might be a radar system, for example, or another command and control system, or a LINK 4A, Link 11, or LINK 16 interface, or any other source. According to an aspect of the invention, the track data signals are transmitted by way of a signal path 14 to a commercial off-the-shelf (COTS) application server arrangement illustrated as a block 16, and the track data signals on path 14 are in a J2EE-compliant format. In this context, an application server arrangement comprises one or more application servers which provide the application server function. The J2EE format is set or maintained by JavaSoft, which can be found at www.javasoft.com. The set 16 of plural application servers represented by blocks 16a,

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16b, . . . , 16M, must be essentially compliant
with the J2EE standard, although it is
recognized that full compliance is seldom found
in any COTS application server. Suitable
5 application servers are (a) Weblogic Enterprise
6.1, manufacture by BEA, whose address is
www.bea.com and (b) Power Tier, manufactured by
Persistence, whose address is
www.persistence.com. Within the application
10 server arrangement 16 of FIGURE 1, a track
management system 18 receives, processes and
maintains the data. In essence, the track
management system 18 processes the data for
storage, and stores the data. In addition, the
15 track management system determines whether the
data represents new data or an update to a
current track, all in known fashion. Within
the track management system, the data is
processed by a set 20 of a plurality of
20 Enterprise Java Bean software components,
represented by blocks 20a, 20b, . . . , 20n.
The set 20 of plural EJB software components
must be essentially compliant with the J2EE
standard, although those skilled in the art
25 will recognize that the compliance need only be
sufficient for operation as described herein.
Physically, the application server arrangement
16 includes a plurality of central processing
units, which are represented by a set 22 of
30 blocks 22a, 22b, . . . , 22N, where N need not
equal n. Instead of individual CPUs, some or

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all

all of the blocks of set 22 may be clusters of CPUs. Instead of individual application servers, some or all of the blocks of set 16 may be clusters of application servers.

5 Instead of individual EJB software components, some or all of the blocks of set 20 may be a plurality of EJB software components.

10 According to an aspect of the invention, the application server arrangement establishes or determines which Enterprise Java Bean software component of set 20 runs on which of the CPUs 22a, 22b, . . . , 22N.

As also illustrated in FIGURE 1, application server 16a may be a part of an
15 application server arrangement 16 which includes a plurality of application servers, some of which are additionally designated 16b, . . . , 16M.

Upon requests for data from an
20 external user of data, such as user 24 of FIGURE 1, the requested data is transmitted, in J2EE compliant format, to the user. The user block which receives the signals may be a sensor, a weapon, or another system or
25 subsystem. The inherent operation of the application server arrangement 16 operating on the Enterprise Java Beans, and in conjunction with the plurality of CPUs of set 22, results in automatic assignment of each Enterprise Java
30 Bean component to one of the processors. In the event of failure of one of the CPUs of set

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22, the application server arrangement 16 automatically reassigns the Enterprise Java Beans to operable processors, unlike the situation in the prior art, in which failure of
5 as few as two CPUs, namely (a) the primary and (b) the secondary or backup could result in failure to run of that software process which was assigned to those two CPUs.

In FIGURE 2, track management system
10 18 is illustrated as including a plurality of track position filter components 220a, 220a', . . . 220aⁿ', . . . , 220aⁿ'. Each track position filter component translates the coordinate information for each track to a common
15 coordinate system. Track management system 18 of FIGURE 2 also includes a plurality of correlators or correlation components, some of which are designated 220b, 220b', and 220bⁿ'.

A correlator determines whether new data
20 received represents a new manifestation of a track which is currently in the data base, or if it is a new entity which should be independently processed. Track management system 18 also includes a plurality of unique
25 identification components 220c, 220c', and 220cⁿ' and of system track data representation components 220n, 220n', and 220nⁿ'. The number of each component which may be in existence at any particular moment depends upon the number
30 of individual processes which are being prosecuted, which in turn means that the number

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of components such as 220a, 220b, 220c, or 220d
(or any others which may be used) equals the
number of Enterprise Java Beans currently in
existence. In other words, the track position
5 filters, correlators, unique identifiers, and
system track data representations of FIGURE 2
are merely particular uses or implementations
of the EJBs of FIGURE 1. The components of the
track management system, and their functions,
10 are well known in the art, and form no part of
the invention.

In general, any number of application
server(s) may be associated with any number of
computer processing arrangements. A computer
15 processing arrangement capable of processing
J2EE compliant software components must be
capable of one of (a) processing Java code, (b)
processing Java byte code, (c) processing Java
byte code through use of a Java virtual machine
20 or its functional equivalent, (d) processing
EJB software components, (e) processing EJB
software components through use of an
application server arrangement, or (f)
processing Corba software components, since
25 Corba software components, which are
functionally equivalent to EJB software
components. In FIGURE 3a, a single application
server designated 16a is associated with a
single computer processing arrangement 22a in a
30 "1:1" arrangement. As noted, a computer
processing arrangement may include a cluster

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having a plurality of central processing units.

In FIGURE 3b, a single application server designated 16a is associated with a plurality of computer processing arrangements, designated 16a, 16b, . . . , 16N, in a "1:N" relationship.

In FIGURE 3c, application servers 16a, 16b, . . . , 16n are associated with a single computer processing arrangement 22a in an "n:1" arrangement. Lastly, in FIGURE 3d, a plurality of application servers designated 16a, 16b, . . . , 16n are associated with a plurality of computer processing arrangements 16a, 16b, . . . , 16N. Thus, the invention allows independence of the allocation of the underlying computer processing arrangement so long as the underlying computer processing arrangements are responsive to COTS application server arrangements.

In general, any number of Enterprise Java Bean(s) may be associated with any number of application servers. In FIGURE 4a, a single Enterprise Java Bean designated 20a is associated with an application server arrangement 16 containing but a single application server 16a in a "1:1" arrangement.

In FIGURE 4b, many similar Enterprise Java Bean software components represented by blocks labelled 20a are associated with an application server arrangement 16 including a plurality of application servers designated 16a, 16b, . . . , 16N in a "1:N" relationship. In FIGURE 4c,

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Enterprise Java Beans 20a, 20b, . . . , 20n are associated with an application server arrangement 16 containing a single application server 16a in an "n:1" arrangement. Lastly, in
5 FIGURE 4d, a plurality of Enterprise Java Beans designated 20a, 20b, . . . , 20n are associated with an application server arrangement 16 including a plurality of application servers 16a, 16b, . . . , 16M. Thus, the invention
10 allows independence of the allocation of the application servers of the application server arrangements with the Enterprise Java Beans so long as the underlying computer processing arrangements are responsive to COTS application
15 server arrangements.

The invention has the advantage of avoiding the need to maintain a store or archive of documentation relating to a plurality of proprietary interconnection
20 standards such as those used in prior-art systems. Often, this documentation was out-of-date, and did not match the actual current practice. Instead, according to the invention, the standards are maintained by the industry
25 groups, and so long as the equipments conform to the industry standards, any designer can use the standards to upgrade, enhance or repair a command and control system according to the invention.

30 In addition to the above advantages, the system according to the invention has the

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additional advantage, by comparison with prior art systems such as the AEGIS weapon system, of providing the ability to dynamically activate or deactivate software components. Further,
5 the processing of software components can be dynamically reallocated or redistributed among processors andor computer processing arrangements. Since systems according to the invention are J2EE compliant, various systems
10 tools such a development and debugging tools, peripherals, and other software components, are readily available. Put another way, systems according to the invention, by contrast with at least some prior art systems, have the
15 flexibility andor capability to rebalance operation in the event of faults or improper load distribution, because the applications operated by the software components are independent of the hardware processors on which
20 the components run.

Those skilled in the art recognize that an application server could be used even if it did not run on a Java virtual machine, but could process the data in the desired
25 fashion and produce the desired results even if it were to run on binary files which execute the machine code, so long as the end computer processing arrangement or CPU is capable of being controlled by the application server.
30 Thus, an application server running C++ could process the Enterprise Java Beans. Corba

software components are functionally equivalent to EJB software components, and may be used in their stead. In general, it is recognized that the technologies in question tend to be
5 combined into assemblages of greater and greater complexity, so that systems including separate or several functional blocks tend to be combined into single blocks or elements which include all the functions of the formerly
10 separate entities. It is anticipated that the system according to the invention may be implemented as a single integrated block lacking obvious separations among the functional elements. In order to use Java byte
15 code, one must necessarily use a J2EE.

FIGURE 5a is a simplified block diagram of a computer processing arrangement 22 capable of processing Java software component 510. The Java software component should be one
20 of (a) Java code, (b) Java byte code, (c) and/or machine code derived from Java code. FIGURE 5b is a simplified block diagram of a computer processing arrangement 22 capable of processing Java 510 through a Java virtual machine 512.
25 FIGURE 5c is a simplified block diagram of a computer processing arrangement 22 capable of processing an EJB software component or software component arrangement 20 through use of an application server or application server
30 arrangement 16 and a Java virtual machine 512.

FIGURE 5d is a simplified block diagram of a

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computer processing arrangement 22 capable of
processing an EJB software component or EJB
software component arrangement 20 through use
of an application server or application server
5 arrangement 16. FIGURE 5d is a simplified
block diagram of a computer processing
arrangement 22 capable of processing a Corba
software component or Corba software component
arrangement 520 by the use of an application
10 server or application server arrangement 16.

Thus, the computer processing
arrangement capable of processing J2EE
compliant software components entails at least
one of (a) processing Java code, (b) processing
15 Java byte code, (c) processing Java byte code
through use of a Java virtual machine or its
functional equivalent, (d) processing EJB
software components, (e) processing EJB
software components through use of an
20 application server, and (f) processing Corba
software components, given that such components
are functionally equivalent to EJB software
components.

Thus, a method according to an aspect
25 of the invention is for operating a command and
control system (10) which includes a track
management system (18). The method includes
the step of providing one or more commercial
off-the-shelf (COTS) application server(s)
30 (16a; 16a, 16b, . . . , 16M) capable of
receiving data in a Java Two Enterprise Edition

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(J2EE) compliant protocol. Target or other data is generated (12) and communicated to the COTS application server arrangement (16) in the form of a Java Two Enterprise Edition (J2EE) compliant protocol. A plurality (22) of computer processing arrangements (22a, 22b, . . ., 22N) are provided, each of which is capable of processing J2EE compliant software components. In other words, the computer processing arrangements (22a, 22b, . . ., 22N) are responsive to a COTS application server arrangement. Each computer processing arrangement (22a, 22b, . . ., 22N) may be a single CPU (with its ancillary equipment), or a group or cluster of computer processors. According to the invention, the method includes, in the application server arrangement (16), processing the J2EE compliant data with a plurality of Enterprise Java Beans software components (20a, 20b, . . ., 20n). In effect, these are components which are capable of being dynamically controlled. The application server arrangement (16) also establishes or determines those of the computer processing arrangements (22a, 22b, . . ., 22N) in which the data is processed. When the computer processing arrangements (22a, 22b, . . ., 22N) which are to process the various portions of the data have been established or determined, the J2EE compliant data is provided to the selected ones of the computer processing arrangements (22a,

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22b, . . . , 22N), for thereby generating
processed data (on path 26). Finally, the
processed data is provided to a user (24).
Most often, the user (24) is another system or
5 subsystem of the command and control system
(10).

A method for operating a track
management system (18) according to another
aspect of the invention includes the step of
10 providing a COTS application server arrangement
(16a; 16a, 16b, . . . , 16M) capable of
receiving data which is pursuant to a Java Two
Enterprise Edition (J2EE) compliant protocol.
Data is generated which represents target
15 information, and the data is communicated to
the COTS application server in the form of a
Java Two Enterprise Edition (J2EE) compliant
protocol. A computer processing arrangement
(22a, 22b, . . . , 22N) is provided. The
20 computer processing arrangement is capable of
processing J2EE compliant software components.

In the application server arrangement, the
J2EE compliant data is processed with one of
(a) an Enterprise Java Bean software component
25 arrangement and (b) a Corba software component
arrangement, to establish or determine those of
the computer processing arrangements in which
the data is processed. The J2EE compliant data
is provided to the selected ones of the
30 computer processing arrangements, for thereby
generating processed data. Finally, the

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processed data is provided to a user.